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International Journal of Nursing and Midwifery

Full Length Research Paper

Determinants of neonatal sepsis among neonates admitted in a neonatal intensive care unit at Jinka General Hospital, Southern Ethiopia

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In the face of recent improvements in neonatal care, the influences of neonatal sepsis remain a public health problem in developing countries. Thus, identifying the determinants of neonatal sepsis is an indispensable matter of enhancing neonatal care. Therefore, this study intends to identify the determinants of neonatal sepsis among neonates admitted to the Neonatal Intensive Care Unit at Jinka General Hospital in Southern Ethiopia. An institution-based case-control study was conducted from September to October 2017. A total of 335 neonates who were admitted at Jinka General Hospital were incorporated. Cases (n=112) were neonates who were with sepsis and their mother. Controls (n=223) were neonates who were not with neonatal sepsis and their mother. Study participants were selected using the simple random sampling technique. Bi-variable and multivariable logistic regression analyses were performed to identify determinants of neonatal sepsis. A total of 335 (112 cases and 223 controls) medical charts of neonates with their index mother was reviewed. History of urinary tract infection during the index pregnancy [AOR= 4.47, 95% CI (2.06, 9.71)], prolonged rupture of membrane [AOR= 2.2, 95% CI (1.24, 3.92)], birth weight of neonate less than 2.5kg [AOR= 1.68, 95% CI (1.25, 3.75)] and birth asphyxia [AOR= 2.34, 95% CI (1.14, 4.81)] were identified as determinants of neonatal sepsis. This study concludes that history of urinary tract infection, prolonged rupture of membrane, birth weight of neonate and birth asphyxia were the independent determinants of neonatal sepsis. Therefore, preventive efforts of neonatal sepsis should focus on high-risk neonates such as neonate born from mothers who have of urinary tract infection and prolonged rupture of membranes, a neonate with low birth weight and neonate who developed neonatal asphyxia by careful monitoring and follow-up as well as by prudently treating the victims.

Key words: Neonatal sepsis, determinants of neonatal sepsis, neonatal intensive care unit.

INTRODUCTION

Neonatal sepsis is a systemic inflammatory manifestation which results from bacterial, viral or fungal invasions of the blood stream. It is considered as a case in the existence of suspected or confirmed infection in the

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neonate (Goldstein et al., 2005; Gebrehiwot et al., 2012). Based on the onset of symptoms, neonatal sepsis can be classified as early neonatal sepsis or late onset sepsis. Early neonatal sepsis (EOS) is primarilyoccurred within the first 72 h of life, whereas late onset sepsis (LOS) is usually present after 72 h of age (Singh et al., 1994).

Globally, around 4 million neonatal deaths occur each year, of which about 98% happens in developing countries, particularly in sub-Saharan Africa (SSA) (WHO, 2014; Edmond and Zaidi, 2010; Leal, 2012). In comparison to developed countries the risk of neonatal death grows into 6 times higher in developing countries. Evidence revealed that neonatal deaths accounted for 52% of all under five child mortality in South Asia, 53% in Latin America and Caribbean and 34% in sub-Saharan Africa (UNICEF, 2014). In Ethiopia, the neonatal mortality rate (NMR) is 29/1000 live births, which has not shown substantial reduction from the 2011 Ethiopia demographic and health survey (EDHS) report (37/1000 live births) (Rockville, 2016).

Furthermore, neonatal sepsis is accountable for 15% of global neonatal deaths and 30-50% of neonatal deaths in developing countries. In SSA, 17% of neonatal deaths are due to neonatal sepsis. Around 37% of Ethiopian neonates also died due to neonatal sepsis, which accounts for more than one third of neonatal deaths (WHO, 2014; UNICEF, 2014; CSA, 2012; Kabwe, 2016).

Furthermore, the world is witnessing a steady decline in the number of neonatal deaths due to sepsis, the neonatal mortality from sepsis declined by only 28 percent (WHO, 2014; Edmond and Zaidi, 2010; Leal, 2012). In spite of Ethiopia's notable achievement in reduction of maternal mortality and attaining millennium development goal (MDG 4) three years before, the reduction in neonatal mortality was relatively low (Mekonnen et al., 2013). Neonatal conditions which were causing under-five mortality in 2004 have recently increased to 43%. Out of these conditions which cause under five mortalities, neonatal sepsis accounts for 9% (World Bank, 2015).

The persistence occurrence of neonatal mortality due to neonatal sepsis is aggravated by the three delays that happened at the household (delay in seeking care), delay in reaching for the care and delay in commencement of care at the health institution. Evidences indicated that neonates died in the community before reaching health institutions for appropriate care and treatment (Edmond, and Zaidi, 2010; Zaidi et al., 2009).

To respond to the persistent neonatal mortality due to neonatal sepsis and other causes the international community was in agreement on new framework of the sustainable development goals (SDGs) to decrease under-five mortality to at least as low as 25 per 1000 live birth by 2030 (Mekonnen et al, 2013). Predominantly, sepsis related mortality is largely avertable with prevention of sepsis itself, timely recognition, rational antimicrobial therapy and aggressive supportive care (Shivaprasad and Sen, 2017).

Even though the impact of neonatal sepsis remains a public health problem in resource limited settings like Ethiopia, limited evidences exist to show the determinants of this serious public health problem in different parts of Ethiopia. Thus, identifying the determinants of neonatal sepsis is very important for optimizing neonatal care. It also augments the current neonatal sepsis management strategies by making sure the various determinants contribute to neonatal sepsis (Goldstein, 2005). Therefore, the aim of this study was to identify the determinants of neonatal sepsis among neonate admitted to the Neonatal Intensive Care Unit (NICU) in Jinka General Hospital, Southern Ethiopia, 2017.

MATERIALS AND METHODS

Study setting, design and participants

Facility-based case-control study was conducted in Jinka General Hospital from September 1 to October 1, 2017. Jinka town is the administrative and business centre of the South Omo zone. The total population estimate in the South Omo zone for 2017 was 722,955 with around 360,517 male and 362,438 female populations (CSA, 2013). In the zone, there are 34 health centers with none of them haing NICU service. Jinka General Hospital is the only functioning hospital which was established in 1991. The hospital has 120 beds and gives inpatient and outpatient services in its general outpatient department, six special clinics (dental, ophthalmic, psychiatric, MCH, ART and TB clinics) and the inpatient department. The NICU ward was established in 2006 and currently staffed with an Obstetrician/Gynecologist, General Practitioner, three Comprehensive Essential Obstetrics and Newborn Care (CEmONC) trained health officers and six trained nurses. The study participants were neonates who were admitted and treated in the NICUs of Jinka General Hospital during January 2015 to January 2017.

Sample size determination and sampling procedure

The required sample size was determined using double population proportion formula by using STATCALC program of the EPI INFO statistical software based on the following assumptions: Proportion of mothers delivery in the hospital among the controls is 28.43% (exposed group); this was taken from another similar study conducted in public hospitals of MekelleCity,Tigray region, 95% CI, power of the study is 80%, control to case ratio of 2:1, odds ratio (OR) of 2 (Gebremedhin et al., 2015). The final required sample sizes that considered 5% for the non-response rate was 335 (112 cases and 223 controls) participants. Cases were neonates with sepsis and controls were neonates without sepsis who were admitted to neonatal ICU of the Jinka General Hospital during the study period. The study participants were selected using a simple random sampling technique by means of table of random method from a list of cases and controls in the log book.

Data source and procedures

The structured data extraction checklist was developed from different peer reviewed published literature (Gebremedhin et al.,

Table 1. Socio-demographic characteristics of cases and controls among neonates admitted in NICU at Jinka General Hospital, South Omo Zone, southern Ethiopia, 2017.

Variables	Category	Cases n (%)	Controls n (%)
Maternal age (years)	15-24	39(34.8)	94(42.2)
	25-34	47(42)	95(42.6)
	≥35	26(23.2)	34(15.2)
Sex of neonate	Male	66(59)	148(66)
	Female	46(41)	75(34)
Neonate age (days)	≥7 days	10(9)	18(8)
	<7 days	102(91)	205(92)

2015; Ahmed and Magzoub, 2015; Schrag et al., 2012). This checklist data was collected by reviewing neonates' medical records at Jinka General Hospital within the time period of January, 2015-January, 2017 by 4 trained nurses. Every day, after data collection, each questionnaire was reviewed and checked for completeness by the principal investigator and the necessary feedback was given to data collectors for the next day.

Data processing and analysis

Data were coded, entered and cleaned using Epi-data version 3.1 and exported to SPSS version 21.0 for analysis. Exploratory data analysis was carried out to check the levels of missing values and presence of influential outliers. Descriptive statistics were computed and presented using frequencies, proportions, summary statistics and tables. Bi-variable and multi-variable logistic regression analysis was performed to see the association between neonatal sepsis and explanatory variables. Variables that were found to be statistically significant in the bi-variable analysis (p - value <0.25) were entered into multi-variable logistic regression model analysis. Finally a multivariable logistic regression analysis was done to identify determinants of neonatal sepsis. A P-value ≤ 0.05 was considered statistically significant in this study. Finally, both crude odds ratios (COR) and adjusted odds ratio (AOR) together with 95% confidence intervals (CI) were calculated and reported.

Data quality control

Data quality was assured by carrying out the careful design of data extraction checklist, appropriate recruitment, training and follow-up of data collectors. Intensive supervision was done by principal investigator during the whole period of data collection. A 5% random sample of registration form was reviewed by the principal investigator to conform reliability of data before data collection. Daily, the data were strictly revised for completeness, consistency, accuracy and clarity by the investigators. In addition, the data were thoroughly cleaned and carefully entered into the computer by Epi data version 3.1 using double entry verification.

Ethical statement

Ethical approval was obtained from Arba Minch University institutional review board (IRB) to conduct the study. Following the approval, the official letter of co-operation was written to Jinka General Hospital administration by the department of Public Health of Arba Minch University. Permission was granted from the JinkaGeneral Hospital administration, where the study conducted, as per the recommendation letter from the department. The confidentiality of information was maintained by not recording their names from the chart and the recorded data were not accessed by a third person.

RESULTS

Socio-demographic characteristics

A total of 335 medical charts of neonates with their mothers were reviewed while medical charts of 112 neonates who had sepsis (cases) and 223 neonates who had no sepsis (controls) were studied. Regarding maternal age, forty seven (42%) of mothers of cases and 95 (43%) mothers of controls were between age 25-34 years. One hundred and two (91%) of the cases and 205 (92%) controls were less than 7 days of age. With regard to sex proportion of neonates, male neonates were higher in the controls 148 (66%) than cases of 66 (59%) (Table 1).

Maternal related characteristics

Eight (7.1%) mothers of cases and 14 (6.3%) mothers of controls were HIV positive whereas, mothers who have given two or more births were higher among cases (68%) compared to controls (66%). One hundred and eighty eight (84%) of control mother and 86 (77%) of cases mothers utilized antenatal care service at least once during the index pregnancy. One hundred forty nine (67%) of controls mother and 76 (68%) of cases mother were delivered by spontaneous vaginal delivery. The majority of the cases mother 96 (86%) and controls mother 197 (88%) give birth in Health institution. Mothers in the cases 27 (24%) have a higher proportion of history of urinary tract infections during the index pregnancy than mothers in the controls 24 (11%) (Table 2).

Neonate related characteristics

One hundred and thirty nine (62%) controls and 61 (54%) cases were delivered at term. The majority of control, 144

Table 2. Maternal characteristics of cases and controls among neonates admitted in NICU at Jinka General Hospital, South Omo Zone, southern Ethiopia, 2017.

Variables	Category	Cases n=112(%)	Control n=223(%)
Maternal HIV status	Positive	8(7.1)	14(6.3)
	Negative	104(92.9)	209(93.7)
Parity	Primeparuos	36(32)	75(34)
	Multiparous	76(68)	148(66)
Antenatal clinic (ANC) attendance	Yes	86(77)	188(84)
	No	26(23)	35(16)
Place of delivery	Health institution	96(86)	197(88)
	Home	16(14)	26(12)
Mode of Delivery	Caesarian-Section	11(10)	33(15)
	Instrumental	25(22)	41(18)
	Spontaneous vaginal delivery	76(68)	149(67)
Duration of labour	≥24 h	23(21)	59(26)
	<24 h	89(79)	164(74)
History of PROM	Yes	50(44.6)	74(33.2)
	No	62(55.4)	149(66.8)
Duration of PROM	<18 h	23(21)	42(19)
	≥18 h	27(24)	32(14)
Urinary tract infection (UTI)	Yes	27(24)	24(11)
	No	85(76)	199(89)

(65%) and 61 (54%) of case gave normal birth weight neonate whereas, 21 (22%) of cases and 23 (11%) of controls had birth asphyxia (Table 3).

Determinants of neonatal sepsis

Maternal age, ANC attendance, history of PROM, history UTI, gestational age, birth weight of the neonate and birth asphyxia were variables found to be statistically significant in bivariate analysis at p-value less than 0.25.

The multivariable logistic regression result showed that a history of UTI during the index pregnancy was significantly associated with neonatal sepsis. Neonates born to mothers who had a history of UTI during the index pregnancy were nearly 4.5 times more likely to develop sepsis than those neonates born to mothers who did not have a history of UTI during the index pregnancy [AOR= 4.47:95%CI (2.06, 9.71)].

According to the finding of this study, neonates born to mothers who gave birth after 18 h of rupture of membranes was 2.2 times more likely to develop sepsis than those mothers who gave birth before 18 h of rupture of membranes [AOR= 2.2:95% CI (1.24, 3.92)].

The study showed that birth weight had a significant association with neonatal sepsis. The neonatal sepsis among neonate who have a birth weight less than 2.5 kg were 1.68 times more likely to developed sepsis compared to those whose birth weighed over 2.5 kgs [AOR= 1.68:95%CI (1.25, 3.75)].

This study also showed that neonate developed birth asphyxia at birth was at risk factors for neonatal sepsis. The neonatal sepsis among neonate who developed birth asphyxia at birth were 2.34 times more likely to develop neonatal sepsis compared to those who did not develop birth asphyxia at birth [AOR= 2.34:95% CI (1.14, 4.81)] (Table 4).

DISCUSSION

This study was designed to identify determinants of

Table 3. Neonatal characteristics of cases and controls among neonates admitted in NICU at Jinka General Hospital, South Omo Zone, southern Ethiopia, 2017.

Variables	Category	Cases n=112(%)	Control n=223(%)
Birth asphyxia	Yes	21(22)	23(11)
	No	75(78)	179(89)
Gestational Age	Preterm	40(36)	58(26)
	Term	61(54)	139(62)
	Post term	11(10)	26(12)
Birth weight	LBW	51(45.5)	79(35.4)
	Normal	61(54.5)	144(64.6)

Table 4. Bi-variable and multivariable logistic regression analyses of neonatal sepsis among neonate admitted in NICU at Jinka General Hospital, South Omo Zone, southern Ethiopia, 2017.

Variables	Category	Cases n=112(%)	Control n=223 (%)	COR(95%CI)	AOR (95%CI)	P-value
Maternal age (years)	15-24	39(35)	94(42)	1	1	
	25-34	47(42)	95(43)	1.19(0.72,1.99)	1.61(0.88,2.93)	0.124
	≥35	26(23.2)	34(15)	1.84(0.98,3.47)	2.00(0.97,4.15)	0.06
Neonate age (days)	<7 days	85(76)	199(89)	2.64(1.44,4.83)	1.04(0.43,2.41)	0.093
	≥7 days	27(24)	24(11)	1	1	
ANC visit	Yes	86(77)	188(84)	1	1	
	No	26(23)	35(16)	1.64(0.92,2.87)	1.07(0.47,2.44)	0.873
History of PROM	Yes	50(44.6)	74(33.2)	1.62(1.02,2.59)	2.2(1.24,3.92)	0.007*
	No	62(55.4)	149(66.8)	1	1	
UTI	Yes	10(9)	18(8)	1.12(0.49,2.51)	4.47(2.06,9.71)	0.001*
	No	102(91)	205(92)	1	1	
Gestational Age	Preterm	40(36)	58(26)	1.63(0.72,3.67)	2.02(0.68,5.98)	0.207
	Post term	11(10)	26(12)	1.04(0.48,2.23)	1.34(0.41,4.41)	0.63
	Term	61(54)	139(62)	1	1	
Birth weight	LBW	51(45.5)	79(35.4)	1.52(0.96,2.42)*	1.68(1.25,3.75)	0.025*
	Normal	61(54.5)	144(64.6)	1	1	
Birth asphyxia	Yes	21(22)	23(11)	2.18(1.14,4.18)*	2.34(1.14,4.81)	0.02*
	No	75(78)	179(89)	1		

PROM, Prolonged rupture of membrane; UTI, urinary tract infections; LBW, low birth weight;* = p-value ≤ 0.05 is statistically significant.

neonatal sepsis among neonates admitted into the NICU in Jinka General Hospital. In this study history of UTI, prolonged rupture of membrane, birth weight of neonate and birth asphyxia were identified as determinants of neonatal sepsis.

The study revealed that mothers who had a history of UTI during the index pregnancy have a statistically significant association with neonatal sepsis. Specifically, neonates born to mothers who had a UTI during the index pregnancy were nearly 5 times more likely to develop sepsis than those neonates born to mothers who did not have a UTI during the index pregnancy [AOR= 4.47:95% CI (2.06, 9.71)]. This finding is supported by the study conducted in Ghana (Siakwa et al., 2014),

Bishoftu, Ethiopia (Woldu et al, 2014) and Mekelle, Ethiopia (Gebremedhin et al., 2015). This might be due to late diagnosis and treating of UTI that could result in an onset of neonatal sepsis by ascending infection of infectious agents of UTI through the vagina.

According to the finding of this study, neonates born to mothers who gave birth after 18 h of rupture of membrane was 2.2 times more likely to develop sepsis than those mothers who gave birth before 18 h of rupture of membranes [AOR= 2.2:95%CI (1.24, 3.92)]. This finding was concurred by studies conducted in different parts of Ethiopia (Gebrehiwot et al., 2012; Gebremedhin et al., 2015; Woldu et al., 2014]. This might be explained by the fact that prolonged labor increases the chance of ascending infection from maternal genital tract.

The neonatal sepsis among neonates who have a birth weight less than 2.5 kg were 1.68 times more likely to develop sepsis compared to those whose birth weighed over 2.5 kgs [AOR= 1.68:95%CI (1.25, 3.75)]. This finding is supported by the studies conducted in Bangladesh (Chan et al, 2013) and Bishoftu, Ethiopia (Woldu et al, 2014).This might be due to the fact that birth weight could affect the immune status of the neonates so that neonates with LBW could easily be vulnerable to infection.

This study also showed that developing birth asphyxia determined the status of neonatal sepsis. Neonates who developed birth asphyxia were 2.34 times more likely to develop neonatal sepsis compared to those who did not develop birth asphyxia [AOR= 2.34:95%CI (1.14, 4.81)]. This finding was supported by a study conducted in Southeastern Mexico and Soweto (Leal et al., 2012; Schrag et al., 2012). This might be due to the availability of microorganisims on the vaginal wall that increased the risk of neonatal sepsis while the child was born and passed through the vaginal wall.

The strengths of this study are the use of standard measurements which are enabled to make the comparison of findings with other national and international literatures to be valid. In addition, the use of control study participants. Whereas the limitation of this study was as the study based on records, the availability of data for a few variables was difficult and those with incomplete information were excluded from the study.

Conclusion

Generally, the finding of this study showed that the occurrence of neonatal sepsis was determined by history of UTI, prolonged rupture of membrane, birth weight of neonate and birth asphyxia during birth. In contrast, the variable like parity, ANC service utilization, mode of delivery, place of delivery, gestational age, neonatal age and maternal age were not the predictors of neonatal sepsis in this study. Therefore, preventive efforts should focus on high risk neonates such as neonates born from mothers who have UTI, PROM, neonate with low birth

weight and neonates that develop neonatal asphyxia.

Thus, a careful monitoring and follow up as well as rigorous treatment are needed; special follow up is needed for high risk neonates.

CONFLICT OF INTERESTS

The authors declare that there was no conflict of interest.

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